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Additional Biological Notes on *Megachile concinna* Smith in Arizona[1]

(Hymenoptera : Megachilidae)

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The life history and nesting habits of *Megachile* (*Eutricharaea*) *concinna* Smith in southern Arizona were discussed by Butler and Wargo (1963). It was concluded at that time that *M. concinna* was not a potentially manageable pollinator in southern Arizona due to the reluctance of the bees to utilize artificial holes for nesting and the presence of a chalcid parasite. The successful management of *M. rotundata* (Fabricius) in northern areas, by Stephen (1962), Bohart and Knowlton (1964), and Hobbs (1964), prompted additional observations on *M. concinna* in 1964 reported in the present paper.

Emergence of bees from straws.—Field collections of leafcutter bees at Tucson indicate that spring generation adults become active during April and May. On 20 June 1964, bees hibernating in milk straws were collected from a research farm and a residence where they

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Table 1. Emergence of *Megachile concinna* adults from straws collected from fields on 20 June 1964, Tucson.

	June			July					
Emergence Dates	24–26	27–29	30–2	3–5	6–8	9–11	12–14	15–17	18–20
Number of Bees	3	0	0	53	92	71	83	36	0

had been in shelters for approximately 11 months. The emergence of adult bees from the straws is shown in Table 1. These results indicate that the end of the emergence of overwintering bees may come as late as the latter part of June, while the emergence of the first generation adults may occur during early July. Observations on pollinator activity in a birds-foot trefoil field and a small alfalfa field several miles away indicated that bees were very numerous in July, but became less abundant in August, and were very scarce in early September. It was of interest that during August a birds-foot trefoil field of about 1 acre was very attractive to the leafcutter bees, while an acre of alfalfa being grown for seed about 100 yards away, had no leafcutter bee activity.

Length of developmental stages.—Milk straws with newly constructed cells were collected at 2-day intervals and brought to the laboratory where they were held in three temperature cabinets (modified household refrigerators). The cabinets were programmed so they had fluctuating temperatures with 12 hours at one temperature and 12 hours at another 20° F higher. The time required for adult bees to develop from the newly laid egg is given in Table 2. The developmental period from egg to adult decreased from approximately 6 weeks, at an average temperature of 75° F, to 4 weeks at 85° F, and to 3 weeks at 95° F.

The duration of the pupal stage was compared in 4 cabinets with 20° F fluctuating temperatures and in 3 with constant temperatures. Larvae which had completed their development were transferred from their cells to small plastic petri dishes and observed daily until they

Table 2. The number of days for the development to adult stage of *Megachile concinna* eggs held in temperature cabinets with 12-hour fluctuating temperatures.

Temperature °F	Number of Bees	Number of Days
75 (65–85)	8	41–44
85 (75–95)	12	26–30
95 (85–105)	11	19–22

Table 3. The duration of the pupal stage of *Megachile concinna* in temperature cabinets with constant and with 12-hour fluctuating temperatures.

Temperature °F	Number of Bees	Duration in Days	
		Mean	Range
65 (55–75)	1	29.0	29
75 (65–85)	3	19.7	19–20
75 constant	3	17.7	17–18
85 (75–95)	3	11.3	10–12
85 constant	6	10.0	10
95 (85–105)	6	9.2	8–10
95 constant	2	8.5	8–9

pupated and changed to adults. These results are shown in Table 3. Development of the pupal stage at a constant 95° F was 8.5 days, or approximately twice as rapid as at a constant 75° F. At the 12-hour fluctuating temperatures, development at an average of 95° F was also twice as rapid as that at 75° F, and three times as rapid as at 65° F. Development took slightly longer at fluctuating temperatures than at constant temperatures.

FLIGHT ROOM OBSERVATIONS.—Preliminary studies were made of the activity of *M. concinna* in a flight room. The room was 8 feet long by 4 feet wide and 6 feet high, made of 2 × 4 inch lumber, and had the sides covered by 6-mill black plastic sheeting sprayed with aluminum paint. The ceiling was covered by white cheese cloth, above which were suspended two 8-foot 4-bulb fluorescent lights, controlled by time clocks. Bees collected in the field or reared from cells in straws were placed in the room. Bouquets of alfalfa flowers, potted alfalfa plants, and a 1 to 3 sugar-water mixture were provided for food and leaves. Boxes of milk straws (5⁄32-inch inside diameter) supplied holes for nesting.

It became difficult to supply a constant pollen source in mid-July as the bees rapidly tripped the flowers on the potted alfalfa plants provided. Ground honeybee-collected pollen was offered but the leafcutter bees were unable to pack it until its stickiness had been removed by washing with 70% alcohol. The bees dropped into the petri dish with the pollen, tumbled around in it for about a half a minute and then flew up to clean themselves and pack the pollen on their abdomens. After gathering a load of pollen, the bees stopped at the sugar-water before going to their cells, where they successfully provisioned them.

Larvae raised in the flight room in mid-July appeared to be almost all in a diapause condition, which would be an advantage in "artificial production." One male bee emerged without a diapause.

Preliminary observations indicate that it may be possible to rear *M. concinna* in a flight room, possibly as small as 9 cubic feet, by providing milk straws in which to nest, alfalfa leaves or other leaves for cell construction, and dishes of pollen and of a sugar-water mixture for provisioning the cells. Only a small percentage of field-collected bees became acclimated to room conditions and made cells, but room-emerged bees might acclimate more readily.

PARASITES AND PREDATORS.—*Tetrastichus megachilidis* Burks was observed as an important parasite of *M. concinna* as in early July 1962, when 20 per cent of the cells were parasitized. Parasitism increased to 42 per cent by mid-September, when as many as 93 per cent of the innermost cells, those containing females, were parasitized, according to Butler and Wargo (1963). In 1964, straws containing cells constructed from 16 to 27 July were brought to the laboratory. Larvae and prepupae were removed and placed in small petri dishes. *T. megachilidis* adults from 12 larvae emerged between 5 and 15 August with a mean developmental time of 20 days and a possible range of from 9 to 30 days. A parasitized *M. concinna* larva was placed in a constant temperature cabinet at 85° F and observed daily. All parasites pupated on 24 July and transformed to adults on 30 July, for a pupal stage of 6 days. The pupal stage of *M. concinna* at this temperature lasted 10 days. Only a few parasites were reared out or observed during July, so it appears that field populations might develop without parasitism from April through June. Cells made during this period could be removed and stored, and should be free of *T. megachilidis.* Cells made after June are likely to be parasitized and, at present, it is not possible to separate cocoons of parasitized bees from those that are unparasitized.

A bombyliid, *Anthrax cintalpa* Cole (det. N. Marston) was reared in 1964 from *M. concinna* cells for the first time in our experience, but only from the first generation and in low numbers. It is apparently associated in the nest blocks with *Chalicodoma chilopsidis* (Cockerell) and *C. occidentalis* (Fox). The bombyliid occurs throughout the mountainous part of the western United States, north to British Columbia and south into southern Mexico, according to Marston (personal correspondence). It was reared by R. W. Thorp from both *M. rotundata* and *M. concinna* in California.

A dermestid, *Trogoderma* sp., was commonly found in boxes of straws brought in from the field. Although it was usually associated with cells from which bees had emerged or in which eggs or larvae had died, there was considerable evidence that beetles were attacking cells with healthy bees, particularly when these cells were constructed in straws with old cells. These beetles, thus, might become a problem following the continued reuse of soda straws in nest boxes.

Discussion

The spring generation adults of *Megachile concinna* appear during April, May, and June and the emergence of the first generation adults takes place during early July. Populations of bees appear to be highest during July and then gradually diminish to relatively low levels by September.

Parasitism appears to be at a minimum during June and July, which suggests that following the pollination of the first alfalfa seed crop, nest boxes should be taken from the field and placed in storage at about 40° F until the following spring. The major limiting factor in the manipulation of this species still appears to be the inability to get the bees to accept artificial nesting holes. Most of our unsuccessful attempts have been made during late July and in August. Perhaps adults from overwintering pupae might accept nesting holes if they were to emerge from them and if nesting sites were available early in the season. There is considerable competition for nesting holes in blocks with the two common species of *Chalicodoma* in June in southern Arizona but these species can not nest very successfully in soda straws.

Preliminary studies in a flight room indicate that it may be possible to rear *M. concinna* indoors by providing milk straws in which to nest, alfalfa leaves or other leaves for cell construction, and dishes of pollen and a sugar-water mixture for provisioning the cells. There are a number of details in this procedure that need to be investigated further, but the technique offers many possibilities for basic studies on the biology of this bee as well as its commercial production.

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